ORIGINAL RESEARCH PAPER
Volume - 12 | Issue - 05 | May - 2023 | PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr
INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

CORRELATION BETWEEN ASSESSMENT OF CUP DISC(CD) RATIO USING OPTIC NERVE HEAD PHOTOGRAPHY AND OPTICAL COHERENCE TOMOGRAPHY(OCT)

Ophthalmology

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ABSTRACT

Background: Various types of modalities exist for examination of the Optic nerve head. As changes in the optic disc are a major indicator of glaucoma it is vital to establish which among the modalities correlate best with each other. In this study the cup to disc ratio was assessed using optical coherence tomography and optic nerve head photography and the findings were compared **Methods:** An observational study was conducted. Group I consisted of 50 patients of primary open angle glaucoma and Group II consisted of 50 non-glaucomatous patients. ONHP and OCT were done to assess the average cup to disc ratio CDR. Average CDR as calculated by the 2 methods was compared by Pearson correlation. Correlation value of +1 is total positive correlation, 0 is no correlation and −1 is negative correlation. **Results:** The correlation value in the case group was 0.86 for CDR. The correlation value in the control group was 0.72 for CDR. **Conclusion:** The study found OCT findings and ONHP findings have weak correlation.

KEYWORDS

Optical coherence tomography (OCT); Optic nerve head photography (ONHP); Average Cup to Disc ratio (CDR).

INTRODUCTION

Glaucoma is a group of ocular disorder that causes progressive optic neuropathy leading to loss of visual function most markedly resulting in limitation of visual field.[1] Glaucoma is responsible for causing the most cases of blindness after cataract.[2] It is a disease that has multiple factors contributing to its cause that ultimately result in raised intra ocular pressure that causes damage to the optic disc resulting in visual field loss. Broadly the two types of Glaucoma are Open Angle and Closed angle glaucoma. Optic nerve head examination is the most important step that raises suspicion of Glaucoma. Intraocular pressure measurement along with changes in the optic disc and visual filed changes help in determining the progression of the disease. The disease process causes damage to the retinal ganglion cells that is most apparent over the optic nerve head. The optic disc is a vertically oval structure placed 3 to 4 mm to the nasal side of the fovea. It is 1.76mm horizontally by 1.92mm vertically. The cup to disc ratio (CDR) indicates the diameter of the disc expressed as a fraction of the diameter of the disc. It has been shown that a good predictor of glaucoma is the cup-to-disc ratio of the optic nerve head. Hence, accurate assessment of the average CDR is the hallmark of glaucoma diagnosis. Optic nerve head analysis to estimate CDR can be done in several ways. Clinically the CDR is assessed by using direct ophthalmoscopy, indirect ophthalmoscopy or slit lamp biomicroscopy (SBM). SBM can be done either with contact lenses (such as a Goldman lens) or non-contact lenses (such as a +78D, +90D or Hruby lens). SBM done using +90D lenses is presently the most common clinical tool employed for analysis of the optic nerve head. Among the newer modalities optical coherence tomography (OCT) is more commonly being used. OCT captures high-resolution, three-dimensional images from within optical scattering media. OCT uses interferometry to measure the reflectance of light at different depths in the ONH and captures laser high-resolution, three-dimensional images. Measurement values like CDR, VCDR etc are derived by identifying and measuring the depth of the reflectance signal. Although clinical assessment using SBM with +90D lens is considered to be the standard modality, there is no modality that is without inherent disadvantages. Hence, keeping in view of the latest advancements in technology, there is a need to compare different methods of assessing ONH and examine the effects of measurement variability across a range of characteristics of different examination techniques.

AIMS AND OBJECTIVES

1. Assessment of optic nerve head using optical coherence tomography and optic nerve head photography.
2. Compare the findings and to study the significance of the difference in the CDR as calculated by the two methods and their correlation.

MATERIALS AND METHODS

A prospective observational study was carried out from 2022-2023. The material of the study were patients attending the outpatient department of Ophthalmology. Patients were examined in two groups. The study group consisted of 50 patients of established cases of Primary open angle glaucoma (POAG) aged between 20 yrs to 70 yrs. The diagnosed cases were based upon characteristic visual field changes, raised intraocular pressure and optic nerve head changes. The control group consisted of 50 age and gender matched patients who were willing and with informed consent who had come for routine ophthalmological check-up.

Inclusion Criteria

Confirmed cases of Primary open angle glaucoma aged between 20 yrs to 70 yrs were included in the case group. Individuals who had features of open angles in gonioscopy, characteristic field changes and optic nerve head changes were included in the study. Control group of consisted of, age and gender matched individuals with no ocular disease, who are willing to give consent.

Exclusion Criteria

1. Individual with refractive errors beyond –12 and +12 dioptres of sphere or between –12 and +12 dioptres of cylinder were excluded.
2. Individuals with pre-existing ocular diseases other than glaucoma were also excluded.
3. Individuals who had optic disc anomalies like tilted disc, optic disc drusen or optic disc coloboma were excluded as it would affect optic disc evaluation.
4. Previous history of ocular surgery.

MATERIALS AND METHODS

A complete history both ocular and medical was taken. Family history of glaucoma was taken. This was followed by clinical evaluation which included assessment of visual acuity and best corrected visual acuity using Snellen's chart. Refraction was performed using streak retinoscopy and auto-refractometer. External eye examination was done using torchlight. The anterior segment was evaluated using a slit lamp. Anterior chamber depth was assessed using Van Herrick method. Particular attention was given to examination of the direct and consensual reflexes to rule out relative afferent pupillary defect. This assessment was done using the swinging flash light test. Lens was evaluated to rule out lens induced causes of glaucoma. The intraocular pressure was measured using Goldmann applanation tonometry. Indirect gonioscopy was performed using Goldmann 3-mirror gonioscope to rule out closed angles and occludable angles. Visual field analysis was done using standard automated static perimetry, threshold 30-2 with Goldmann size III target, a 31.4 asb, white background and full threshold strategy. All the information was recorded in a set proforma. Optic nerve head photography and optical coherence tomography were done for all patients. Optic nerve head was done for all patients. A fundus digital image using Zeiss VISUPAC fundus camera FF 450 was taken for each patient. The margins of optic cup and the optic disc was marked after loading in 1-image split view mode. The cup and disc was circumscribed as two separate areas using the Closed Polygon or Freehand contour function. Then using the measure mode in the VISUPAC software, cup area, disc area, disc diameter and cup diameter were measured. CDR was calculated as a ratio of cup area to disc area was calculated as an average of cup

diameter to disc diameter. Evaluation on OCT was done using the Fast Optic Disc Protocol on the Zeiss Stratus OCT Model. The optic disc cube 200 × 200 protocol was used to acquire RNFL thickness measurements and measurements of disc area and CDR. This protocol is based on a 3-dimensional (3D) scan of a 6 × 6 mm area centred on the optic disc in which information from a 1024 (depth) × 200 × 200-point parallelepiped is collected. The parapapillary RNFL thickness measurements were calculated from a 3.46-mm-diameter circular scan (10.87-mm length) automatically placed around the optic disc. The average RNFL thickness corresponds to the 360° measure automatically calculated by the OCT software (software version 6.0; Carl Zeiss Meditec, Inc.). The optic nerve head (ONH) algorithm was used to determine features of the ONH, including disc size and CDR, from the same 3D data cube. The disc margin is identified as the termination of Bruch's membrane and the limit of the optic cup is automatically determined from the change in the thickness of the neuro-retinal rim tissue as it exits the opening in Bruch's membrane. The Cirrus SD-OCT images were reviewed and included if the signal strength was >7, if movement artefacts and segmentation errors were absent, and if there was good centring on the optic disc.

Statistical Methods

Descriptive and inferential statistical analysis was carried out in the study. Results on continuous measurements were presented on Mean SD (Min-Max) and results on categorical measurements were presented in Number (%). Significance was assessed at 5 % level of significance. Student t test (two tailed, independent) was used to find the significance of study parameters on continuous scale between two groups (inter group analysis) on metric parameters. Pearson correlation between study variables was performed to find the degree of relationship.

Classification of Correlation Co-efficient ®
Up to 0.1 Trivial Correlation
0.1-0.3 Small Correlation
0.3-0.5 Moderate Correlation
0.5-0.7 Large Correlation
0.7-0.9 Very Large Correlation
0.9- 1.0 Nearly Perfect correlation
1 Perfect correlation

RESULTS

The study was conducted in 200 eyes of 100 patients and a comparative case-control study was done.

Table 1: Age Distribution Of Patients Studied

Age in years	Controls		Cases	
	No	%	No	%
<40	2	4.0	1	2.0
40-50	9	18.0	7	14.0
51-60	11	22.0	14	28.0
61-70	16	32.0	14	28.0
71-80	12	24.0	12	24.0
>80	0	0.0	1	2.0
Total	50	100.0	50	100.0
Mean ± SD	60.48±12.27		61.04±11.61	

Samples are age matched with P=0.815 as per the Student t test. The mean age was 60.48±12.27 ranging

Table 2: Gender Distribution Of Patients Studied

Gender	Controls		Cases	
	No	%	No	%
Female	25	50.0	25	50.0
Male	25	50.0	25	50.0
Total	50	100.0	50	100.0

Samples are gender matched with P=1.000, Chi-Square test

Table 3: CDR Values Calculated Using Optical Coherence Tomography

Optical Coherence Tomography	Controls	Cases
Cup to disc ratio (Right eye)	0.41±0.13	0.75±0.10
Cup to disc ratio (Left eye)	0.43±0.13	0.74±0.12

Table 4: CDR Values Calculated Using Optic Nerve Head Photography

Optic Nerve head Photography	Controls	Cases
Cup to disc ratio (Right eye)	0.38±0.11	0.68±0.12
Cup to disc ratio (Left eye)	0.40±0.11	0.66±0.11

Table 5: Pearson Correlation Of Study Outcome Between The Methods Optical Coherence Tomography And Optic Nerve Head Photography

Optical Coherence Tomography VS Optic Nerve head Photography	Controls (r value)	Cases (r value)
Cup to disc ratio (Right eye)	0.79	0.83
Cup to disc ratio (Left eye)	0.65	0.88

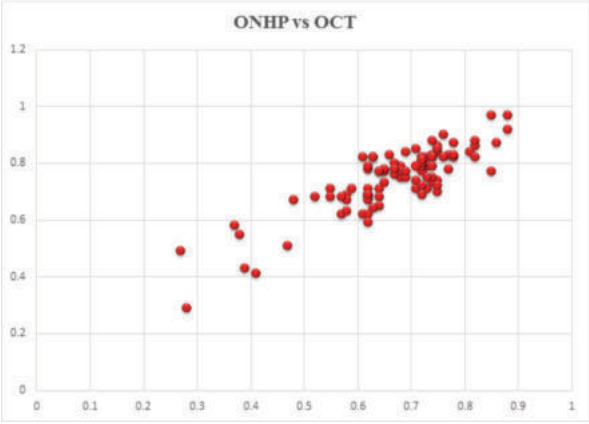

Chart 1: Scatter Plot Analysis Of CDR In Cases Of Glaucoma Comparing ONHP And OCT

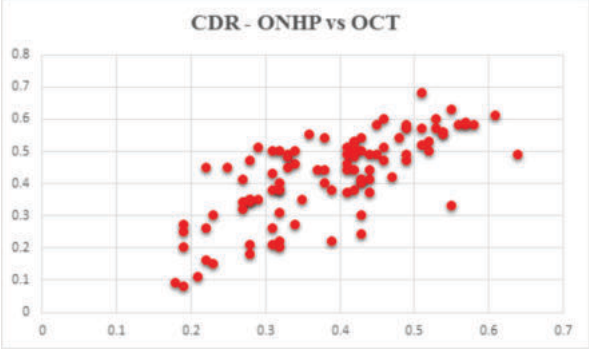

Chart 2: Scatter Plot Analysis Of CDR In Controls Comparing ONHP To OCT

DISCUSSION

This comparative case control study was conducted in 200 eyes of both glaucomatous and non-glaucomatous eyes. The mean age of Group I (Cases) individuals was 61.04±11.61 years and the mean age of Group II (Controls) was 60.48±12.27 years. Student t test was applied to study whether the study populations matched and P value of 0.815 was obtained. This indicated that the age of samples was gender matched. We found that as much as 32 percent of cases of POAG belonged to age group between 60 to 70 years of age with a very low 2% of the cases below the age of 40 years. Suzuki e al in his study found the average age of POAG patients to be 63.8 ± 12.0 years which correlates with our study. Age of incidence of glaucoma. In a study conducted in Denmark by Miriam Kolko et al between 1996 to 2011, the average age at onset was 66 (range: 0–105) years. Mean age for females was 68 years compared to 64 years for males. Chandra et al found the mean age of patients to be 52.98 years. It was the intended in this study to have age and gender matched population. It was also intended to have equal number of male and female population. Hence, equal number of sexes were recruited for the study. This was done in order to eliminate bias.
Optical coherence tomography was performed on all individuals. Evaluation on OCT was done using the Fast Optic Disc Protocol on the Zeiss Stratus OCT Model. The findings were recorded in .pdf format and tabulated. The mean CDR was 0.42 for both eyes for normal. For cases of POAG, the mean CDR was 0.75.

Optic nerve head photography was done by obtaining a fundus digital image using Zeiss VISUPAC fundus camera FF 450 for each patient. The mean CDR was 0.39 for both eyes for normal. For cases of POAG, the mean CDR was 0.67.

In this study we deduced that the correlation value in controls for OCT vs ONHP was 0.72 for CDR. And the correlation value in cases for OCT vs ONHP was 0.86. The correlation between two tests was between ONHP and OCT was weak. Better correlation between the investigative modalities was seen among cases than in controls.

Scatter graphs were plotted using the data. All the scatter plots showed a similar pattern rising from bottom left to upper right. This indicated that all the tests showed positive correlation with each other. The scatter plots were plotted for CDR for both cases and controls. The scatter plots showed higher number of scatter plots in the upper right side for cases in comparison with controls representing higher correlation.

In this study we have discovered, that although all the two tests correlate well with each other, the correlation was not very strong especially in control cases. In addition, although OCT is user independent and extremely reliable modality, caution should be exercised when using OCT when assessing glaucoma suspects as they may give higher values and overestimate higher CDR. Optic nerve head evaluation is of utmost importance in the evaluation for glaucoma and it should be always be recorded. It is best if the clinician initially assesses CDR by using SBM and records which of the methods was used to examine the optic nerve head in order to avoid confusion so that subsequent clinical decisions are not influenced by apparent changes.

CONCLUSION

The following conclusions were drawn from the study

1. In this study we have discovered, that all the two tests correlate weaky with each other.
2. Both tests in addition to being a tool for assessment of optic disc also helps in objective documentation of changes.

Conflict Of Interests: The authors declare that they have no conflicting interests

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